AFRL-ML-WP-TP-2007-500

PHOTOVOLTAIC INDUCED GRATING INSTABILITIES (Preprint)

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Hardened Materials Branch

FEBRUARY 2006

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
February 2006	Conference Paper Preprint	

4. TITLE AND SUBTITLE

PHOTOVOLTAIC INDUCED GRATING INSTABILITIES (Preprint)

5a. CONTRACT NUMBER
IN-HOUSE

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
62102F

6. AUTHOR(S)

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5d. PROJECT NUMBER
4348

5e. TASK NUMBER
RG

5f. WORK UNIT NUMBER
M03R1000

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Agile Filters Project, Exploratory Development
Hardened Materials Branch, Survivability and Sensor Materials Division
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Air Force Materiel Command, United States Air Force

Anteon Corp.

8. PERFORMING ORGANIZATION REPORT NUMBER

AFRL-ML-WP-TP-2007-500

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Air Force Research Laboratory
Materials and Manufacturing Directorate
Wright-Patterson Air Force Base, OH 45433-7750
Air Force Materiel Command
United States Air Force

10. SPONSORING/MONITORING AGENCY ACRONYM(S)
AFRL/MLPJ

11. SPONSORING/MONITORING AGENCY REPORT NUMBER(S)
AFRL-ML-WP-TP-2007-500

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES
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14. ABSTRACT

- The PV field is responsible for undesirable grating recording noise, or spikes in transmitted power.
- Corresponding spikes in the transmission of light incident at the Bragg angle indicate the grating is partially destroyed rather than momentarily dephased.
- The noise is most likely due to a sudden strong current and/or avalanche current flow through the bulk crystal, such that the E_{sc} is randomized and the grating is partially destroyed.

15. SUBJECT TERMS
Photovoltaic Induced Grating, Two-Beam Coupling, Contra-Directional Coupling

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT:	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON (Monitor)
a. REPORT	b. ABSTRACT	c. THIS PAGE			Dean R. Evans, Ph.D.
Unclassified	Unclassified	Unclassified	SAR	12	19b. TELEPHONE NUMBER *(Include Area Code)* (937) 255-4588

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

Photovoltaic Induced Grating Instabilities

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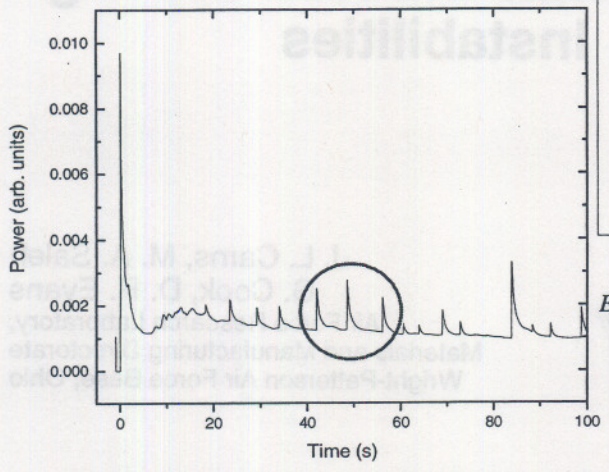
Outline

- Motivation
- Experimental Setup
- Experimental Results in Congruent $LiNbO_3$:Fe
- Conclusions

Motivation

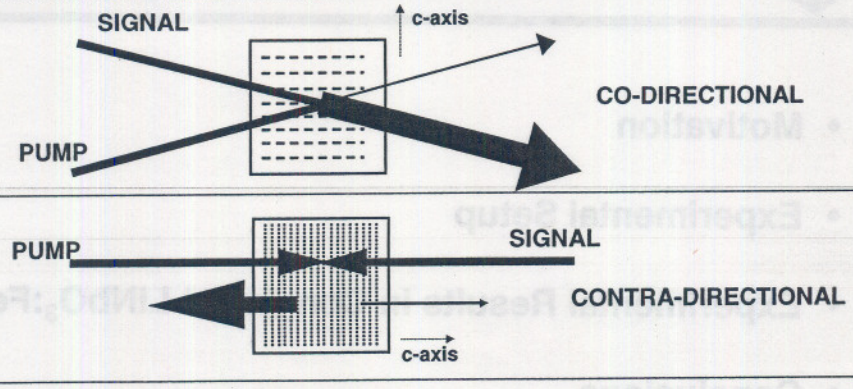


$$E_{sc}(z) = \frac{-\left(E_0 + iE_d + E_{pv}\right)m(z)}{1 + \frac{E_d}{E_q} - i\left(\frac{E_0}{E_q} + \frac{N_a E_{pv}}{N_d E_q}\right)}$$

Evans et al., "Understanding and eliminating photovoltaic induced instabilities in contra-directional two-beam coupling in photorefractive $LiNbO_3$:Fe," Optical Materials, in press.

Evans et al., "Elimination of Photorefractive Grating Writing Instabilities in Iron-doped Lithium Niobate," IEEE J. Quant Elect., 38, 1661 (2002).

Two-beam coupling in $LiNbO_3$:Fe



Contra-Directional Coupling:

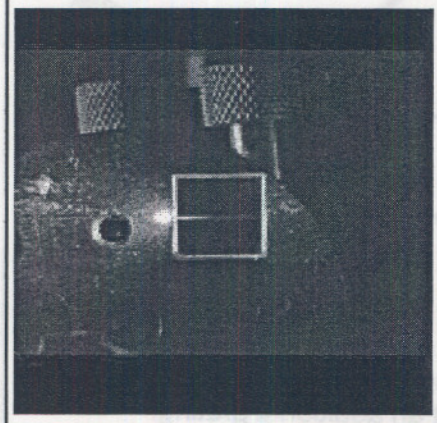
- Good spatial overlap of focused beams
- Decreased recording time
- Minimizes the grating spacing
- Maximizes the diffusion field
- Needs high trap density

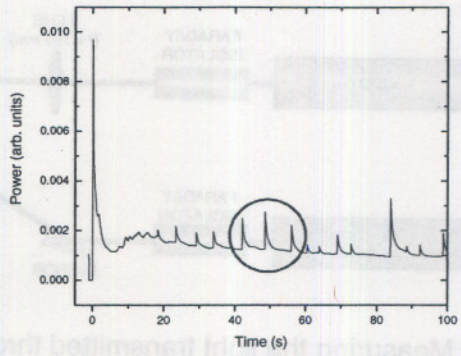
$$m\lambda = 2d\sin\theta$$

$$E_D = \frac{2\pi k_b T}{e\Lambda} \qquad \Lambda_{opt} = 2\pi\sqrt{\frac{\varepsilon_s k_b T}{e^2 N_A}}$$

The space charge field is increased because Λ approaches Λ_{opt} in $LiNbO_3$

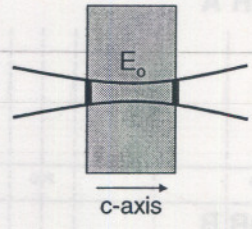
Effect of two-beam coupling in Region B





Two-beam coupling noise

The sudden burst of light through the crystal indicates almost complete "loss" of the grating



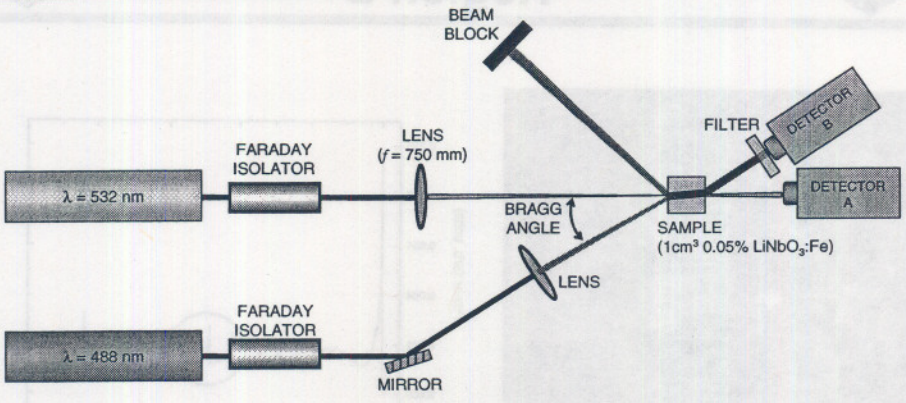
This could be due to:

1) a sudden strong current and/or avalanche current flow through the bulk crystal, such that the E_{sc} is randomized and the grating is partially destroyed

OR 2) the build-up of E_0 causes the grating to become dephased

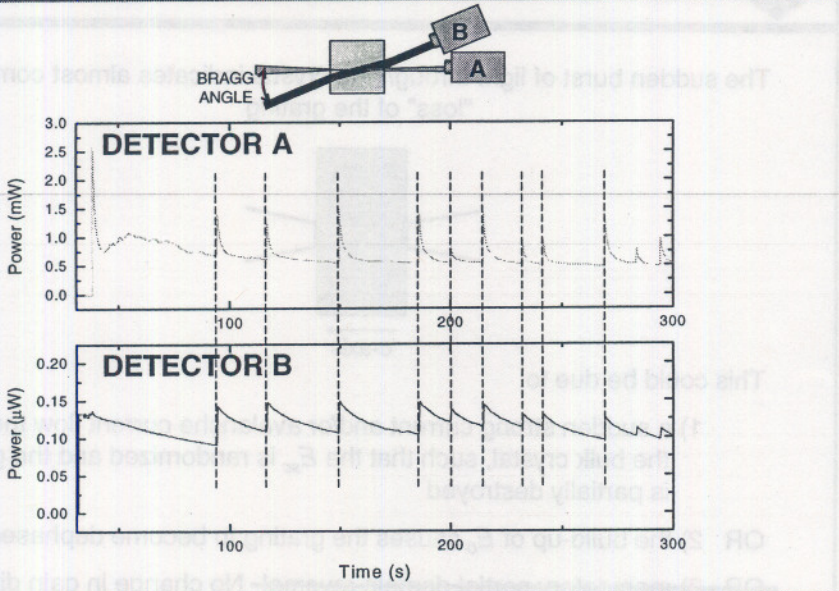
~~OR 3) momentary partial domain reversal~~ No change in gain direction

Experimental Setup

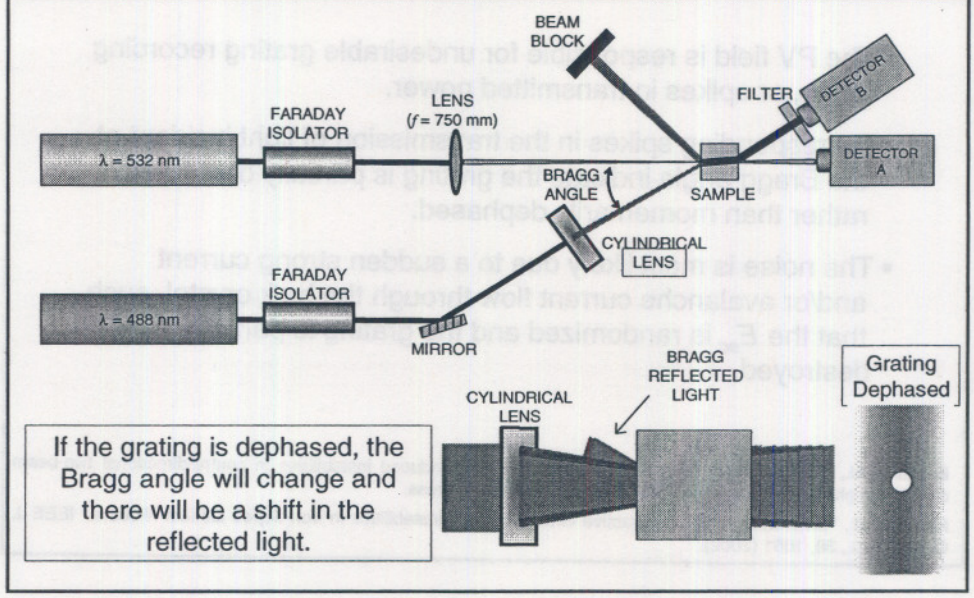


- Measuring the light transmitted through the crystal for both lines.
- Low power at Bragg angle to prevent an additional grating.
- A filter on Detector B blocks any scattered light from the 532 nm line.

Results

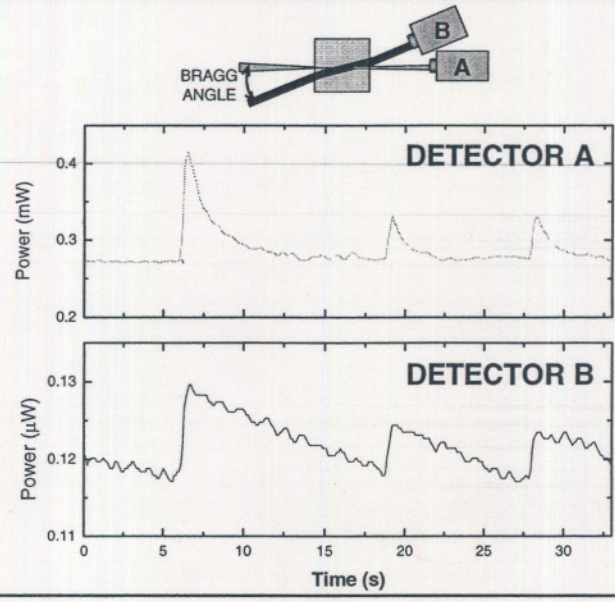


Experimental Setup (Cylindrical Lens)



If the grating is dephased, the Bragg angle will change and there will be a shift in the reflected light.

Results (Cylindrical Lens)



Conclusion

- The PV field is responsible for undesirable grating recording noise, or spikes in transmitted power.
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